

SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING
JANUARY 1934

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Beginning with this month there are included in addition to the intensity measurements heretofore given in the REVIEW, the computed atmospheric turbidity factor, β , and the water-vapor content, w , expressed as the depth of the water in centimeters that would be obtained were all the vapor precipitated. The value of β is computed by the method illustrated in the REVIEW for March 1933, volume 61, page 83, table 2¹ where the method of computing w is also shown. Dr. Herbert H. Kimball, of the Blue Hill Meteorological Observatory, states, relative to these measurements:

No great accuracy can be claimed for the values from Blue Hill, for the reason that the thermopile used to obtain a continuous record of the radiation intensities is not well protected from the wind. As a result the record trace is often quite feathery in appearance. The effort is now being made to afford better protection of this instrument from the wind.

In obtaining the value of the precipitable water, w , a deduction of 1 percent of the solar constant, or 0.01 from the value of $I_{w=0} - I_m$ has been made, which is Fowle's approximate value of the absorption by the permanent gases of the atmosphere.²

The importance of extreme accuracy in the radiation measurements will be appreciated from the fact that an error of 0.01 gr. cal./min./cm² in the measurement of I_m , I_v , or I_r , may cause an error of 0.005 in the computed value of $\beta_{I_m - I_r}$, and of at least twice that magnitude in $\beta_{I_v - I_r}$, with corresponding errors in $I_{w=0}$ and $I_{w=0} - I_m$.

Table 1 shows that solar radiation intensities averaged above normal for January at Washington and Madison, and close to normal at Lincoln.

Table 2 shows an excess in the total solar and sky radiation received on a horizontal surface at Chicago, New York, La Jolla, and New Orleans, and a deficiency at all other stations for which we have normals.

Polarization measurements obtained on 3 days at Washington give a mean of 61 percent with a maximum of 63 percent on the 31st. These are close to normal values for the month. No polarization measurements were obtained at Madison during January because Lake Mendota was continuously frozen and the ground intermittently covered with snow.

¹ Please see the REVIEW for January 1933, 61:4, where it is stated that for the transmission coefficients of the yellow and red glass screens the values 0.882 and 0.871 should be used instead of 0.889 and 0.878, respectively, as given in the table.

² See Smithsonian Meteorological Tables, 5th revised edition, 1931, table 111, and Fowle's estimate of the ozone absorption in the visible spectrum, page lxxxv, of the same tables.

TABLE 1.—Solar radiation intensities during January 1934

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D.C.

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	Air mass										
	75th mer. time	A.M.					P.M.				
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
Jan. 2	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Jan. 10	3.45	0.66	0.82	0.88	1.30	1.28	1.09	1.00	0.88		3.15
Jan. 11	3.99	.73	.83	.97	1.26						3.63
Jan. 16	3.63										3.15
Jan. 18	4.17		.90								2.87
Jan. 20	1.78				1.21						1.88
Jan. 23	2.74						1.37				2.62
Jan. 24	6.02									.98	6.02
Jan. 25	1.78	.90	.94	1.14							1.78
Jan. 26	2.87	.66	.88	1.00	1.16						4.17
Jan. 30	.66		.89								.56
Jan. 31	.76		.76	.88	1.33		1.30	1.12	.83	.68	1.12
Means		.73	.85	.97	1.25		1.32	1.14	(.92)	.85	
Departures		+.01	±.00	+.05	+.02		+.08	+.09	+.03	+.05	

MADISON, WIS.

Jan. 15	2.87	1.02	1.18	1.32	1.49						2.36
Jan. 16	2.49	1.11	1.25	1.35	1.50			1.35			2.09
Jan. 23	1.96	1.12	1.22	1.32	1.44						1.96
Jan. 25	3.63	1.07	1.17	1.27	1.45			1.30			4.95
Jan. 28	1.96		1.16	1.23							1.19
Jan. 29	.36				1.47			1.31			.59
Means		1.08	1.20	1.30	1.47			1.32			
Departures		+.12	+.15	+.10	+.12			+.16			

LINCOLN, NEBR.

Jan. 8	1.78							1.20	0.95	0.82	2.16
Jan. 13	2.87							1.32	1.18	1.06	2.36
Jan. 16	2.87	0.74	0.91	1.02				1.24	1.06		3.99
Jan. 17	2.87			1.21				1.17	1.03		3.63
Jan. 18	3.15			1.22				1.16			4.57
Jan. 19	2.36							1.15	1.04	.93	3.15
Jan. 20	3.63	.72	.82	1.00	1.24			1.03	.85	.70	5.56
Jan. 22	4.57	.94	1.14	1.29				1.24	1.08	.92	3.99
Jan. 23	3.81		1.06	1.23	1.35						3.45
Jan. 25	.96	.94	1.02	1.22	1.36		1.33	1.10			1.45
Jan. 26	1.68	.93	1.03	1.19	1.45		1.39	1.21			2.62
Jan. 30	1.12		.99								2.29
Jan. 31	2.06	.69	.88	1.12	1.39						3.99
Means		.83	.98	1.17	1.36		(1.36)	1.18	1.03	.89	
Departures		-.10	-.06	-.01	-.01		+.02	+.01	-.01	-.04	

BLUE HILL, MASS.

Jan. 2	7.7									0.91	2.2
Jan. 6	4.2							0.89	0.80		5.4
Jan. 11	3.1						1.26	.92			3.4
Jan. 12	3.3						1.18				3.4
Jan. 16	2.4						1.34	1.02	.91	.81	2.6
Jan. 17	1.9			1.22	1.22						1.3
Jan. 18	1.6			1.32	1.43			1.30			1.0
Jan. 19	3.3								1.00	.84	2.5
Jan. 20	1.9			.78	.72						2.1
Jan. 22	2.1						1.08	.81			2.5
Jan. 24	1.8				1.38		1.38	1.17	1.05		1.9
Jan. 25	1.8			1.05	1.24						2.8
Jan. 30	.5			1.20	1.32						.6
Jan. 31	1.5			1.10	1.20						1.3
Means				1.11	1.22		1.25	1.02	.94	.85	

* Extrapolated.

TABLE 2.—Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface

Week beginning—	Gram calories per square centimeter														
	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Mount Washington
1934	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Jan. 1	75	68	115	37	75	152	40	7	170	278	329	188	258	177	116
Jan. 8	127	85	121	60	114	84	57	7	167	344	281	249	299	136	118
Jan. 15	209	164	191	161	180	73	130	8	175	323	282	182	309	190	222
Jan. 22	171	172	258	165	135	288	105	8	144	302	340	126	319	149	121
Departures from weekly normals															
Jan. 1	-75	-61	-74	-42	-27	+10	-49	+1	+13	+33	+37	+38			
Jan. 8	-24	-53	-76	-22	+6	-64	-40	±0	-12	+90	-3	+71			
Jan. 15	+44	+6	-18	+59	+68	-101	+23	-2	-12	-84	-8	-6			
Jan. 22	-5	-11	+19	+50	-13	+78	-5	-6	-43	+42	+16	-49			
Accumulated departures on Jan. 29															
	-420	-833	-1,043	+315	+238	-539	-497	-56	-378	+1,743	-294	+378			

TABLE 3.—Total, I_m and screened, I_v , I_r , solar radiation intensity measurements, obtained during January 1934, and determinations of the atmospheric turbidity factor, β , and water-vapor content, w =depth in centimeters, if precipitated

AMERICAN UNIVERSITY, WASHINGTON, D.C.

Date and hour angle	Solar alti- tude	Air mass	I_m	I_v	I_r	β_{I_m-r}	β_{I_v-r}	β_{mean}	$\frac{I_m-I_r}{1.94}$	$\frac{I_v-I_r}{1.94}$	W
									Percentage of solar constant		
<i>Jan. 10</i>	°	m	gr. cal.	gr. cal.	gr. cal.						cm
2:28 a.-----	19 58	2.90	0.891	0.700	0.591	0.106	0.100	0.103	54.6	0.088	0.4
2:23 a.-----	20 30	2.84	0.924	0.709	0.595	0.100	0.092	0.096	56.5	0.096	0.2
<i>Jan. 11</i>											
2:12 a.-----	14 26	3.96	0.842	0.703	0.585	0.090	0.056	0.078	51.5	0.089	0.3
3:06 a.-----	15 14	3.78	0.854	0.708	0.589	0.090	0.064	0.077	52.7	0.089	0.3
3:01 a.-----	15 54	3.62	0.912	0.742	0.629	0.088	0.068	0.078	53.9	0.073	0.2
2:57 a.-----	16 26	3.50	0.937	0.745	0.635	0.085	0.075	0.080	54.7	0.071	0.2
2:49 a.-----	17 29	3.30	1.000	0.780	0.647	0.085	0.055	0.060	60.1	0.098	0.4
2:45 a.-----	22 59	3.21	1.011	0.785	0.650	0.085	0.053	0.059	60.8	0.097	0.4
1:25 a.-----	28 55	2.06	1.266	0.898	0.724	0.037	0.042	0.040	75.4	0.111	1.0
0:21 a.-----	29 00	2.06	1.272	0.904	0.729	0.037	0.042	0.040	75.4	0.108	1.0
<i>Jan. 24</i>											
3:28 a.-----	14 11	4.02	0.925	0.727	0.619	0.068	0.063	0.065	55.1	0.078	0.2
3:24 a.-----	14 47	3.86	0.968	0.732	0.623	0.046	0.065	0.056	57.8	0.094	0.3
2:53 a.-----	19 06	3.04	1.139	0.861	0.700	0.040	0.032	0.036	67.6	0.097	0.4
2:32 a.-----	21 48	2.68	1.217	0.902	0.733	0.040	0.030	0.035	71.6	0.098	0.5
2:27 a.-----	22 24	2.61	1.244	0.908	0.739	0.030	0.034	0.032	72.1	0.089	0.5

Sky conditions at time radiation measurements were made. International meteorological symbols have been employed to designate clouds, wind, and optical phenomena, hz for haze, and v for visibility. ☉=solar corona.

Jan. 10. P_2O_5 and other fumes and smoke from local blast furnace interfered somewhat. Cu. ended observations. N 2; v 30.
 Jan. 11. No clouds; NW 2; v 30-50.
 Jan. 24. Local smoke, Ast. at 10 a. NW 3; v 20.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

[Data furnished through the courtesy of Dr. Herbert H. Kimball]

Date and hour angle	Solar altitude	Air mass	I_m	I_v	I_r	β_{I_m-r}	β_{I_v-r}	β_{mean}	$\frac{I_m-I_r}{1.94}$	$\frac{I_v-I_r}{1.94}$	W
									Percentage of solar constant		
Jan. 6	°	m	gr. cal.	gr. cal.	gr. cal.						cm
2:26 p-----	16 40	3.61	0.840	0.633	0.539	0.034	0.100	0.092	51.4	0.095	0.4
Jan. 11											
2:05 a-----	19 46	2.93	.875	.672	.552	.100	.100	.100	55.0	.114	1.0

TABLE 3.—Total, I_m , and screened, I_v , I_r , solar radiation intensity measurements, obtained during January 1934, and determination of the atmospheric turbidity factor, β , and water-vapor contents w =depth in centimeters, if precipitated—Continued.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY—Continued

Date and hour angle	Solar altitude	Air mass	I_m	I_v	I_r	β_{I_m-r}	β_{I_v-r}	β_{mean}	$\frac{I_m-I_r}{1.94}$		W
									$\frac{I_m-I_r}{1.94}$		
									Percentage of solar constant		
<i>Jan. 12</i>	°	m	gr. cal.	gr. cal.	gr. cal.						cm
1:42 a.-----	22 15	2.63	1.084	0.817	0.660	0.068	0.061	0.064	63.0	0.090	0.4
<i>Jan. 15</i>											
0:34 p.-----	26 12	2.26	1.233	.918	.720	.049	.023	.036	75.0	.135	2.8
<i>Jan. 17</i>											
2:05 a.-----	20 41	2.81	1.218	.913	.753	.049	.052	.050	67.0	.062	.2
<i>Jan. 18</i>											
2:07 a.-----	20 10	2.88	1.330	.940	.784	.018	.053	.036	70.4	.048	.1
<i>Jan. 20</i>											
2:12 a.-----	20 35	2.82	.808	.616	.484	.098	.084	.091	57.9	.176	-----
1:26 a.-----	24 32	2.40	.902	.682	.539	.104	.088	.096	61.9	.160	-----
0:02 p.-----	27 37	2.15	.726	.590	.451	.187	.107	.147	55.1	.189	-----
<i>Jan. 22</i>											
0:20 p.-----	27 50	2.14	1.035	.769	.616	.096	.086	.091	64.6	.126	2.0
<i>Jan. 24</i>											
1:57 a.-----	22 52	2.56	1.260	.926	.722	.026	.010	.018	77.4	.145	3.5
1:19 a.-----	25 55	2.28	1.305	.911	.744	.030	.062	.046	72.5	.073	.3
0:07 a.-----	28 31	2.09	1.393	1.006	.810	.032	.030	.031	77.5	.079	.3
<i>Jan. 25</i>											
2:22 a.-----	20 34	2.82	1.095	.798	.638	.044	.088	.066	63.6	.089	.4
1:58 a.-----	23 00	2.55	1.179	.861	.680	.040	.034	.037	72.2	.136	2.5
1:24 a.-----	25 47	2.29	1.207	.866	.681	.040	.037	.038	74.4	.140	3.2
<i>Jan. 31</i>											
2:17 a.-----	23 31	2.50	1.119	.840	.677	.067	.050	.062	66.7	.107	.9
1:12 a.-----	28 05	2.12	1.183	.849	.681	.052	.066	.059	70.9	.117	1.5

1 Reduced to value at mean solar distance.

Jan. 11, 2 Cl; hz; ☉; v 7; WSW 3.
 Jan. 12, 2 Cl; hz; ☉; v 6; NW 1.
 Jan. 15, 1 Acu, 2 Cu; v 9; NW 1.
 Jan. 17, few Acu, 1 Cu; ☉; v 8; WNW 7.
 Jan. 18, lt hz; ☉; v 9; NNW 7.
 Jan. 20, 2:12, a.m.; ☉; dns hz; v 4; NE 1. 0:02, p.m.; 2 Cl; dns hz; v 4; NEN 1.
 Jan. 22, 0:20, p.m.; 3 Cl, few Cu; hz; v 7; S 2.
 Jan. 24, 1:57, a.m.; 2 Acu; ☉; lt hz; v 8; NW 7. 1:19, a.m.; 1 Acu; ☉; lt hz; v 8; NW 6.
 Jan. 24, 0:07, p.m.; lt hz; ☉; v 8; NWN 6.
 Jan. 25, 2:22, a.m.; 2 Cl; hz; v 6; SSW 5. 1:58, a.m.; 1-2 Cl; v 6; SWS 5.
 Jan. 31, 2:17, a.m.; few Acu; v 8; SW 3.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U.S. Navy, Superintendent U.S. Naval Observatory. Data furnished by the U.S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. Difference in longitude is measured from the central meridian, positive west. North latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern stand- ard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longi- tude	Lat- tude	Spot	Group		
1933								
Jan. 1.	h. m.	°	°	°				
Jan. 1.	14 52	No spots						U.S. Naval.
Jan. 2.	13 58	No spots						Do.
Jan. 3.	11 12	No spots						Mount Wilson.
Jan. 4.	11 18	No spots						Do.
Jan. 5.	11 26	No spots						Do.
Jan. 6.	11 18	No spots						Do.
Jan. 7.	10 51	No spots						Do.
Jan. 8.	11 43	No spots						U.S. Naval.
Jan. 9.	12 0	No spots						Do.
Jan. 10.	11 50	No spots						Do.
Jan. 11.		No spots						Do.
Jan. 12.	12 45	+4.0	147.4	+5.0	16	16		Mount Wilson.
Jan. 13.	12 30	+18.0	148.4	+5.0	29	29		Do.
Jan. 14.	12 50	+32.0	149.1	+4.0	42	42		Do.
Jan. 15.	11 27	+45.0	149.7	+4.5	46	46		U.S. Naval.
Jan. 16.	13 19	+59.0	149.5	+4.5	69	69		Do.
Jan. 17.	11 52	+73.0	151.1	+4.5	69	69		Do.
Jan. 18.	11 36	No spots						Do.
Jan. 19.	11 35	No spots						Do.
Jan. 20.	11 44	No spots						Do.
Jan. 21.	12 56	No spots						Do.
Jan. 22.	10 50	No spots						Mount Wilson.
Jan. 23.	13 52	No spots						U.S. Naval.
Jan. 24.	11 5	No spots						Do.
Jan. 25.	11 30	No spots						Do.
Jan. 26.	13 56	No spots						Do.
Jan. 27.	11 46	No spots						Do.
Jan. 28.	13 1	No spots						Do.
Jan. 29.	11 20	No spots						Do.
Jan. 30.	11 26	-47.0	220.2	+30.0	39	39		Do.
Jan. 31.	11 21	-34.0	220.1	+30.0	39	39		Do.
Mean daily area for January							11	

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR JANUARY 1934

(Dependent alone on observations at Zurich and its station at Arosa)

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

January 1934	Relative numbers	January 1934	Relative numbers	January 1934	Relative numbers
1	0	11	0	21	0
2	0	12	Mc 8	22	
3		13	11	23	
4	0	14	12	24	0
5	0	15	13	25	0
6	0	16		26	0
7	0	17	11	27	0
8	0	18		28	0
9	0	19	0	29	Ec 8
10	0	20		30	11
				31	

Mean: 24 days=3.1.

c = New formation of a center of activity; E, on the eastern part of the sun's disk; W, on the western part; M, in the central zone.

AEROLOGICAL OBSERVATIONS

[Aerological Division, L. T. Samuels, temporarily in charge]

By L. T. SAMUELS

Free-air temperatures for January, as shown in table 1, averaged above normal at all stations except Boston and Pensacola. Departures of considerable magnitude occurred at Omaha, and Pembina. Relative humidity departures for the month were of opposite sign to those for temperature except at Cleveland, Dallas, and Omaha, where the departures were positive for both of these elements.

In most cases the resultant free-air wind directions for the month did not differ appreciably from the normals

(table 2). Moderate excesses in the resultant velocities were general at the northern stations but elsewhere no consistent variations from the normals occurred.

During January, the International month for 1934, 46 sounding balloons were released from the Omaha Airport Station. To date 33 of the meteorographs carried by these balloons have been returned.